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FOR

SENIOR HIGH SCHOOL

MATHEMATICS 20

September, 1966

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OBJECTIVES OF MATHEMATICS 20

1. To develop the students' awareness of the role of the function as a unifying concept.
2. To develop an appreciation of mathematics as a method of thinking and communicating.
3. To review algebraic concepts developed in previous courses.
4. To extend the students' understanding of number systems and further develop skill in operating with numbers through a study of radicals, exponents and logarithms.
5. To extend the students' knowledge of basic geometric concepts.
6. To extend the student's ability to apply his knowledge of mathematics to the solution of problems.

COURSE OUTLINE FOR MATHEMATICS 20

Prerequisite: "B" or better standing in Mathematics 10.

Text:

SECONDARY SCHOOL MATHEMATICS, Grade Eleven,—Beesack, MacLean et al

Teacher References:

Elliot, Fryer, Gardner, Hill: *Senior Mathematics 2,* Alberta Edition, Holt, Rinehart, Winston.

Dolciani, Berman, Wooton: *Modern Algebra and Trigonometry Book 2, Teacher's Edition,* Houghton Mifflin.

These references may be obtained from the School Book Branch, 10410 - 121 Street, Edmonton, Alberta.

NOTE:

It is recommended that students use mathematical tables whenever possible. Teachers should encourage students to obtain individual copies of *Knott's Mathematical Tables* (revised edition) or *Castle's Five-figure Logarithmic and Other Tables* and should give instruction in the use of these tables.

**CONTENT:*

1.	Real Numbers, Equations and Inequations (Chapter 1)	4 weeks
2.	Exponents, Square Roots, Radicals (Chapter 2)	3 weeks
3.	Introduction to Binary Relations (Chapter 3)	5 weeks
4.	Relations, Functions (Chapter 4)	
5.	The Linear Function and its Application (Chapter 5)	3 weeks
6.	Systems of Linear Equations (Chapter 6)	2 weeks
7.	Exponents, The Exponential Function (Chapter 7)	2 weeks
8.	Logarithmic Functions, Sections 8.1 - 8.9 (Chapter 8)	2 weeks
9.	The Quadratic Function and its Applications (Chapter 9, omitting section 9.15)	7 weeks
10.	Introduction to the Theory of Quadratic Equations (Chapter 10)	
11.	The Circle, Section 11.1 - 11.9 Chapter 11)	4 weeks

Sections of the text listed as "supplementary" and Chapter 12 (trigonometry) are not included in the minimum course. The suggested time schedule above provides broad limits to guide the teacher in covering the course. The total of 32 weeks allows for testing and review. More specific suggestions are provided below for each chapter. Classes which move ahead quicky may wish to have their work enriched by including some of the supplementary sections, or some of the trigonometry. However Chapter 12 will be included in the sequent Mathematics 30 text and course.

SUGGESTIONS FOR TEACHING MATHEMATICS 20

(Effective September, 1966)

The Mathematics 20 teacher should be thoroughly familiar with the Mathematics 10 course which was authorized September, 1965. The language and concepts developed in that course are *basic* to the sequent matriculation courses. Use of correct mathematical language to encourage precise communication is recommended.

The teacher should be aware of the specfic objectives of this mathematics course and should keep them in mind when planning lessons and evaluation.

Careful preparation on the part of the teacher is essential. A preliminary survey of the text to determine what topics have been included and how they relate to each other is suggested. This survey should be followed by a detailed study of each chapter before presentation of any topic contained in it.

The detailed chapter study may suggest opportunities: 1) for students to read and discover concepts themselves, 2) to use visual aids, 3) to suggest other books to students for individual exploration, and 4) to use interesting supplementary material for enrichment.

For the guidance of the teacher a suggested time schedule for each chapter is given. For the purposes of the guide a period is defined as being approximately forty minutes in length.

CHAPTER I — Real Numbers Equations and Inequations

The main topics are:

1. Review of the properties of the real number system.
2. Review of the solution of linear equations.
3. The factor theorem.
4. Solution of equations by factoring.
5. A review of the use of the signs of inequality.

Comments: The review of the real number system could be a reading assignment followed by a brief class discussion, although some re-teaching may be necessary. Work periods in which the students do the exercises should occupy most of the time spent on this chapter.

Time: While three weeks should be adequate time for reviewing the material of this chapter, additional days have been provided for those teachers who find it necessary to supplement the work on factoring.

Suggested time schedule:

Sections 1.1 to 1.5	— 4 periods
Section 1.6	— 2 periods
Section 1.7	— 3 periods
Sections 1.8 and 1.9	— 2 periods
Review and testing	— 2 periods

CHAPTER II — Exponents, Square Roots, Radicals

The main topics are:

1. Positive, zero and negative integral exponents.
2. Square roots — principal square roots.
3. Operations with radicals.
4. Radical equations in one variable.

Comments: The treatment of the above topics is very similar to that in Bowers, Miller and Rourke. The laws of operations for exponents which are positive integers are reviewed and extended to include zero and the negative integers. The usual topics involving radicals are included: simplification, addition, subtraction, multiplication, and rationalization of denominators. The solution of radical equations is a new topic but it should present no particular difficulty.

Three things are worth noting:

1. The use of the word "exponent" instead of "index", since "index" is used in so many ways that it no longer has a precise meaning.

2. The use of the absolute value symbol to ensure that the principal square root is positive when it contains a variable.

3. The need to check for extraneous roots when both sides of a radical equation has been squared.

Suggested time schedule:

Sections 2.1 to 2.4	— 2 periods
Sections 2.5 to 2.8	— 2 periods
Sections 2.9 and 2.10	— 2 periods
Section 2.11	— 1 period
Sections 2.12 and 2.13	— 1 period
Section 2.14	— 1 period
Section 2.15	— 1 period
Sections 2.16 and 2.17	— 2 periods
Review and Testing	— 2 periods

CHAPTERS III and IV — Relations, Functions

The main topics are:

1. Binary relations.
2. Ordered pairs.
3. Graphs of relations.
4. Analysis of relations.
5. A function and its inverse.

Comments: Section 3.1 and 3.2 could be used as a reading assignment to establish the language and symbolism of the chapter.

Using graphs, develop the concepts of domain and range before attempting the algebraic determination. It seems advisable when graphing inequations to use a "test point" to determine which half-plane is defined. Care must be taken when graphing inequations involving absolute value.

The use of the discovery exercises, leading to the concept of a function, is strongly recommended. *It is important to note that the definition of a function differs from that given in traditional texts.* If any vertical line cuts the graph of a relation in more than one point, then the relation is *not* a function.

Note that the graphs of a function and its inverse are symmetrical with respect to the line defined by $y=x$, $x \in R$.

Suggested time schedule:

Sections 3.1 to 3.3	— 5 periods
Sections 3.4 to 3.7	— 5 periods
Section 3.8	— 2 periods
Sections 3.9 to 3.10	— 4 periods
Sections 4.1 to 4.5	— 7 periods
Review and testing	— 2 periods

CHAPTER V — The Linear Function and Its Application

The main topics are:

1. The general linear relation: $L=\{ (x, y) \mid Ax+By+C=0, x, y \in R \}$ where A, B and C $\in$ R, with not both A and B zero.
   The general linear function: $F=\{ (x, y) \mid Ax+By+C=0, x, y \in R \}$ where A, B and C $\in$ R, $B \neq 0$.
2. The graph of the linear relation and its properties.
3. Forms of the equation of a straight line.
4. Use of equations of (3) to introduce the concept of "families of lines" and parameters.
5. Conditions for parallelism and perpendicularity.
6. Length and mid-point of a line segment.
7. Tests for collinearity.

Comments: This chapter introduces the student to some of the elementary topics of co-ordinate geometry. The text presentation uses the discovery approach. Teachers should, therefore, make judicious selection of exercises, choosing particularly those which relate to the development of the new concept which follows. Much can be lost if too many exercises are done. Keep the general concept of "the linear

function" before the student as he studies the details of the chapter. Carefully organize the chapter before presentation in order to use time efficiently.

Suggested time schedule:

Section 5.1	— 1 period
Section 5.2	— 1 period
Sections 5.3, 5.4, 5.5, 5,6, 5.9	— 7 periods
Sections 5.7, 5.8	— 1 period
Sections 5.10 to 5.14	— 4 periods
Review and Testing	— 2 periods

CHAPTER VI — Systems of Linear Equations

The main topics are:

1. Determining the intersection (solution) set of two linear relations graphically.
2. Determining the intersection set algebraically by:
   (a) Comparison
   (b) Substitution
   (c) Addition or subtraction.
3. The number of solutions.
4. Linear equations with literal coefficients.

Comments: The students should become familiar with the set notation used in this chapter. However, do not require the actual algebraic solutions to be cluttered up with set notation. Set notation may be used to express the answer. If exercises 16, 17, page 130 are solved, the students should complete the discovery of the relation of the "family of lines" on the intersection of two given lines. (Section 6.3). This will give another opportunity to become familiar with the use of parameters. This chapter can be covered quickly if the material is carefully organized. Teachers may feel the need to add some work in "problem solving" involving a system of linear equations in two variables.

Suggested time schedule:

Section 6.1	— 3 periods
Section 6.2	— 2 periods
Section 6.4	— 2 periods
Section 6.5	— 2 periods
Review and Testing	— 2 periods

CHAPTER VII — The Exponential Function

The main topics are:

1. Review: 1) Definitions and laws of exponents for integral exponents.
   2) Scientific notation.
2. Principle nth root of a real number.
3. Exponents which are rational numbers.
4. Exponents which are real numbers.
5. Operations with exponents, including the use of the table.
6. Graph of the exponental function.

Comments: Reading assignments can be made since the student is already familiar with much of the material of this chapter. The new material involves finding definitions for $a^{1/n}$, $a^{x/n}$ and $a^{-x/n}$ in order to extend exponents to include rational and real numbers. These definitions are made in such a way that the new exponents will conform with the laws already established for integral exponents. They involve placing restrictions on a or n. The student should learn to perform the operations of multiplication, division, raising to powers, taking roots, using graphs or tables.

Suggested time schedule:

Sections 7.1 to 7.3	— 2 periods
Sections 7.4 to 7.8	— 5 periods
Sections 7.10, 7.11	— 3 periods

CHAPTER VIII — Logarithmic Function

The main topics are:

1. The inverse of an exponential function is a logarithmic function
   (a) Graph
   (b) New notation
2. The relation between exponential and logarithmic functions.
3. Basic properties of logarithms.
4. Change of base.
5. Systems of logarithms.
6. The common logarithm of a number.
7. Antilogarithms.
8. Operations involving the use of logarithms.

Comments: Review the concept of the inverse function and graph the inverses of some exponential functions. Introduce logarithmic notation for inverse functions and the basic properties of logarithms. Students should learn to use the common logarithms (base 10) to perform basic operations.

Suggested time schedule:

Section 8.1	— 2 periods
Sections 8.2, 8.3	— 4 periods
Sections 8.4 to 8.9	— 4 periods
Review and Testing	— 2 periods

CHAPTERS IX AND X — Quadratics

The main topics are:

1. The quadratic function:
   (a) the graph
   (b) maximum, minimum, range,—interpreted graphically and algebraically
   (c) related problems.
2. The quadratic equation and its roots.
3. Problems involving quadratic equations.
4. Equations which give rise to quadratics.
5. Quadratic inequations.

Comments: The students begin by graphing functions of the form $y=ax^2+bx+c$, $x, y \in R$, where $a, b, c, \in R$, $a \neq 0$. They do so by determining ordered pairs of the function. Some guidance should be given in the selection of these ordered pairs. Discovery Exercise 9.2 is used to evaluate the role of "a". In each graph, attention is focused on:

a. The maximum or minimum of the function
b. The value of x for which the function is a maximum or minimum
c. The coordinates of the vertex of the graph
d. The range of the function
e. The intercepts on each axis
f. The equation of the axis of symmetry of the graph

In Section 9.7 the completed square form of the function is used to determine the range algebraically. This section will require practice if it is to be effective in solving maximum, minimum problems.

By this time the students should realize that the solution of the equation $ax^2+bx+c=0$ determines the x-intercepts of the graph of the function. In order to solve the equation three methods are used.

a. Factoring
b. Completing the square
c. General quadratic formula

The formula demonstrates that not all quadratic equations have two real roots. Since Section 9.15 is omitted, no work with complex numbers has been included in this course outline.

If the student can sketch the graphs of quadratic functions readily, then he can sketch, without difficulty, the graphs of quadratic inequations.

Problems such as Example 4, Section 9.8 and Part B, Exercise 9.13 are recommended for enrichment only.

The following time schedule, and order of topics, is suggested:

Sections 9.1 to 9.4	— 3 periods
Sections 9.7 to 9.8	— 5 periods
Section 9.5	— 2 periods
Sections 9.11, 9.12, 9.14	— 3 periods
Sections 10.1 to 10.3	— 6 periods
Section 9.13	— 3 periods
Sections 9.16 to 9.17	— 5 periods
Section 9.18	— 3 periods
Review and Testing	— 3 periods

CHAPTER XI — The Circle

Comments: The content of the geometry in this chapter is very similar to that in the previously authorized "Locus and Circle" booklet. It differs mainly in that there are only two major theorems given in a formal manner: The Inscribed Angle Theorem and the converse of one of its corollaries, the Basic Concyclic Point

Theorem. The rest of the usual theorems are given either as corollaries of the two basic theorems or are organized in groups and given as exercises. These groups are the "Chord Property Theorems" of Section 11.2 and the "Tangent Property Theorems" of Section 11.8. The only important theorem not so included is given in Problem 9 of Exercise 11-3.

The emphasis is on application of the theorems rather than on memorization, and, since there are many more problems than are needed for an average class, a judicious selection will be made.

Before starting Chapter XI it is suggested that 3 or 4 periods be spent in review. The class might well be given a list of last year's theorems such as that on page 448 of the Grade X text. In particular, the following theorems will be needed:

Vertical Angle Theorem
Isosceles Triangle Theorem
Right Bisector Theorem
Angle Bisector Theorem
Exterior Angle Theorem
Parallel Line Theorem
Triangle Angle Sum Theorem
Congruence Theorems
Pythagorean Theorem
Triangle Proportionality Theorem.

The following time schedule is suggested for 4 weeks:

Review of Grade X work	— 3 periods
Sections 11.1 to 11.3	— 3 periods
Sections 11.4 and 11.5	— 4 periods
Sections 11.6 and 11.7	— 1 period
Section 11.8	— 3 periods
Section 11.9	— 3 periods
Review and testing	— 2 periods

If less time is available, the content of the theorems, rather than their proofs, should be emphasized. The plausibility and student acceptance of the theorems and corollaries may be established by inductive means or the proofs may be explored and developed in class, the hypotheses then accepted without the formal writings of proofs.

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